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HYPERBARIC CHAMBER EQUIPMENT: A CONSOLIDATED EQUIPMENT
LIST FROM SELECTED..(U) SCHOOL OF AEROSPACE MEDICINE
BROOKS AFB TX P J SHEFFIELD ET AL. DEC 83

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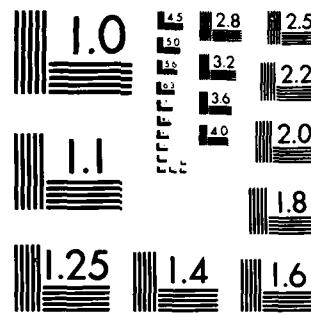
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AD-A141 702

Report USAFSAM-TR-83-34

(12)

**HYPERBARIC CHAMBER EQUIPMENT:
A CONSOLIDATED EQUIPMENT LIST FROM
SELECTED MULTIPLACE HYPERBARIC FACILITIES**

Paul J. Sheffield, Colonel, USAF, BSC

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December 1983

Final Report for Period 10 October 1982 - 15 May 1983



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**USAF SCHOOL OF AEROSPACE MEDICINE
Aerospace Medical Division (AFSC)
Brooks Air Force Base, Texas 78235**



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NOTICES

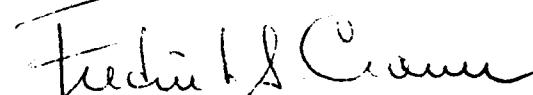
This final report was submitted by personnel of the Hyperbaric Medicine Division, USAF School of Aerospace Medicine, Aerospace Medical Division, AFSC, Brooks Air Force Base, Texas, under job order HM888202.

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The Office of Public Affairs has reviewed this report, and it is releasable to the National Technical Information Service, where it will be available to the general public, including foreign nationals.

This report has been reviewed and is approved for publication.


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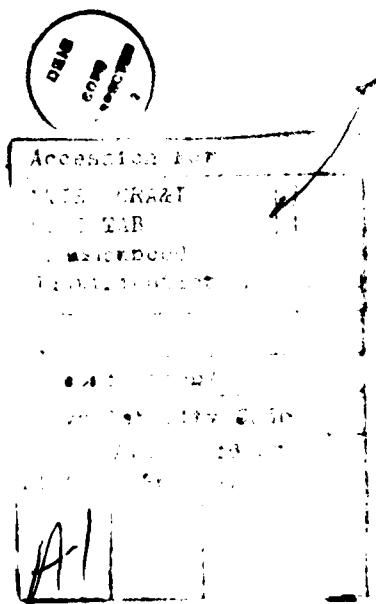
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20. ABSTRACT (continued)

Hyperbaric Medicine is a rapidly expanding treatment modality. Thus, it is becoming increasingly important to make available for planners of such a facility, a list of medical and chamber support equipment that can be used in the high-pressure environment. As indicated in this document, a wide variety of medical and chamber support equipment is currently being used in hyperbaric chambers. Information on the items listed herein was provided by the twenty-two respondents. It is, therefore, presumed, but not verified, by the authors that the items function as advertised in the pressure environment. There may also be equal or better items in each category that are not known to the authors. The inclusion of any item on this list does not constitute any stated or implied endorsement of that product by the authors or the United States Air Force.



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HYPERBARIC CHAMBER EQUIPMENT:
A CONSOLIDATED EQUIPMENT LIST
FROM SELECTED MULTIPLACE HYPERBARIC FACILITIES

I. INTRODUCTION

During October 1982, the Hyperbaric Medicine Division requested information from approximately 40 clinical multiplace hyperbaric facilities in the United States and Canada about the equipment they are currently using inside hyperbaric chambers. Twenty-two responses provided the information contained in this consolidated list of medical and chamber support equipment.

Two areas of inquiry were addressed: Chamber monitoring and ancillary support equipment, and medical support equipment. Chamber monitoring and ancillary equipment included gas/vapor monitoring equipment, carbon dioxide scrubbers, air conditioning, communications, lighting, and fire detecting and fire extinguishing systems. Medical support equipment was limited to patient monitoring equipment, automatic ventilators, and chamber cleaning/sterilization.

This study was undertaken to develop a list of equipment that is currently being used in hyperbaric chambers. As indicated in the list, some items must be adapted with special devices (such as nitrogen purging) in order to be used in the hyperbaric environment. Wherever possible, the source of equipment (manufacturer and address) is provided. Although a product may be contained on this list, there is no stated or implied endorsement of that product by the authors or by the United States Air Force.

II. LIST OF RESPONDENTS

<u>RESPONDENT</u>	<u>RESPONDENT NUMBER</u>
CALIFORNIA	
Long Beach Naval Shipyard Long Beach CA 90822	1
Commercial Diving Center 272 South Fries Ave. Wilmington CA 90744	2
CONNECTICUT	
Naval Submarine Medical Research Laboratory Naval Submarine Base New London Groton CT 06349	3
FLORIDA	
Department of Respiratory Care Services Hyperbaric Chamber Box J-373 Shands Teaching Hospital Gainesville FL 32610	4
National Oceanic and Atmospheric Administration Diving/Hyperbaric Center 4301 Rickenbacker Causeway Miami FL 33149	5
Bay Memorial Medical Center Hyperbaric Medicine P.O. Box 2515 Panama City FL 32401	6
Naval Diving and Salvage Training Center Panama City FL 32407	7
ILLINOIS	
Hyperbaric Medicine Edgewater Hospital 5700 Ashland Ave. Chicago IL 60660	8

II. LIST OF RESPONDENTS (continued)

<u>RESPONDENT</u>	<u>RESPONDENT NUMBER</u>
<u>MINNESOTA</u>	
Minneapolis Medical Research Foundation Hyperbaric Chamber 501 Park Ave. Minneapolis MN 55415	9
<u>NEW YORK</u>	
Hyperbaric Chamber Mt. Sinai Hospital 1 Gustav L. Levy Pl. New York NY 10029	10
<u>PENNSYLVANIA</u>	
Institute for Environmental Medicine Medical Center (G2) University of Pennsylvania Philadelphia PA 19104	11
<u>RHODE ISLAND</u>	
Naval Underwater System Center Newport RI 02840	12
<u>TEXAS</u>	
Hyperbaric Facility Marine Biomedical Institute J-15 200 University Blvd. Galveston TX 77550	13
SD25 Hyperbaric Chamber NASA Lyndon B. Johnson Space Center Houston TX 77058	14
Hyperbaric Medicine USAF School of Aerospace Medicine Brooks AFB TX 78235	15
Hyperbaric Medicine, P.A. Methodist Hospital 4499 Medical Drive, SL2 San Antonio TX 78229	16

II. LIST OF RESPONDENTS (continued)

<u>RESPONDENT</u>	<u>RESPONDENT NUMBER</u>
<u>WASHINGTON</u>	
Hyperbaric Unit Virginia Mason Hospital 925 Seneca St. Seattle WA 98101	17
<u>WISCONSIN</u>	
Hyperbaric Medicine Dept. St. Luke's Hospital 2900 W. Oklahoma Ave. Milwaukee WI 53215-0003	18
<u>CANADA</u>	
Fleet Diving Unit (Pacific) FMO Victoria, British Columbia Canada V0S 1B0	19
Fleet Diving Unit (Atlantic) CFB Shearwater Shearwater, Nova Scotia Canada B0J 3AO	20
Defense and Civil Institute of Environmental Medicine 1133 Sheppard Ave. West P.O. Box 2000 Downsview, Ontario Canada M3M 3B9	21
Hyperbaric Department Toronto General Hospital 101 College St. Toronto, Ontario Canada M5G 1L7	22

III. HYPERBARIC CHAMBER MANUFACTURERS

<u>HYPERBARIC CHAMBER MANUFACTURER</u>	<u>RESPONDENT NUMBER</u>
ABCO P.O. Box 268 Abilene TX 79604	13
Allis Chalmers Large Specialty Products Operations P.O. Box 512 Milwaukee WI 53201	18
Bethlehem Corp. 25th & Lewnox St. Easton PA 18042	3
Biggs United (Add. unknown)	18
Dixie Manufacturing 1518 W. Patapsco Ave. Baltimore MD 21230	7, 16
Dominion Forge Company, Ltd. 2480 Seminole St. Windsor, Ontario Canada N8Y 4R6	19
Duocom (Add. unknown)	20
F. W. Glitsch P.O. Box 226227-TR Dallas TX 75226	15
Hodge Boiler Works 111 Sumner St. East Boston MA 02128	1
Milwaukee Boiler MFG 1101 S. 41st St. P.O. Box 15510 Milwaukee WI 53215	12
Perry Oceanographics P.O. Box 10416 Rivera Beach FL 33404	7, 16

III. HYPERBARIC CHAMBER MANUFACTURERS (continued)

	<u>RESPONDENT NUMBER</u>
Seattle Boiler Works 500 S. Myrtle St. Seattle WA 98108	17
Seibe Gorman (Add. unknown)	19
Union Carbide Old Ridgebury Rd. Danbury CT 06718	10
Vacudyne Altair 375 E. Joe Orr Rd. Chicago Heights IL 60411	4, 8, 9, 11, 14
Well Production Systems, Inc. P.O. Box 22896 Houston TX 77027	13, 16
Wilmington Welding and Fabrication (Add. unknown)	2

OTHER KNOWN MANUFACTURERS OF MULTIPLACE HYPERBARIC CHAMBERS
NOT CITED BY RESPONDENTS*

Environmental Tectonics, Inc.
County Line Industrial Park
Southampton PA 18966

Hahn & Clay
5100 Clinton Dr.
Houston TX 77020

Nautilus Enviromedicals, Inc.
5400 Mitchelldale
Suite B-4
Houston TX 77092

Sanders & Thomas, Inc.
11 Robinson St.
Pottstown PA 19464

Southwest Research Institute
8500 Culebra Rd.
San Antonio TX 78284

*There may be other manufacturers that are not known by
the authors.

IV. CHAMBER MONITORING AND ANCILLARY SUPPORT EQUIPMENT

<u>A. MONITORS</u>	<u>MODEL</u>	<u>RESPONDENT NUMBER</u>
1. CARBON DIOXIDE		
Beckman Instruments, Inc. 1630 S. State College Anaheim CA 92806	Mod 864 Mod LB-1 Mod LB-2 Mod unspec	3, 7, 17 18 6 10
Draeger Werk Drukkammertechnick Auf dem Baggersand 17 2400 Lubeck-Travmunde 1 B.R.D.	Test tube kit	5, 19, 22
Infra Red Industries, Inc. P.O. Box 989-T Santa Barbara CA 93102	Mod 703d-1-004	21
MSA 600 Penn Blvd. Pittsburg PA 15235	Mod 300 & 303	11
Perkin Elmer Medical Products 2771 North Garey Ave Pomona CA 91767	Mod MGA 1100	13
2. OXYGEN		
Beckman (Add. prev. given)	Mod OM-11 Mod OM-14 Mod OM-15 Mod 755	15 6 18 3
Biomarine Instruments 45 Great Valley Parkway Malvern PA 19355	Mod 245 Mod 202r Mod 222r Mod 233 Mod OM-300 Mod 301	4 5, 8 5 5 13 22
Critikon-Oxygen (Add. unknown)	Mod 2000	22
Draeger (Add. prev. given)	Test tube kit	20, 22
Hays Republic Division Milton Roy Co. 4335 S. Ohio St. Michigan City IN 46360	Mod unspec	10

MODEL RESPONDENT NUMBER

2. OXYGEN (continued)

Perkin Elmer (Add. prev. given)	Mod MGA 1100	13
Taylor Instruments/ Servomex Products Analytical Products Division Sybron Corp. 221 Rivermoor St. Boston MA 02132	Mod OA-137 & 540A 11 Mod OA-250 Mod OA-580	11 17 17
Teledyne Analytic Instruments 16830 Chestnut St. P.O. Box 1580 City of Industry CA 91749-1580	Mod 323D Mod unspec	3 2, 7
Ventronics P.O. Box 572 Pemecula CA 92390	Mod unspec	16

3. CARBON MONOXIDE

Beckman (Add. prev. given)	Mod 315 AL	11
Draeger (Add. prev. given)	Test tube kit	5, 20, 22
Enmet Corp. 2308 S. Industrial Hwy. Ann Arbor MI 48104	Mod ISA-33RAH	11
Honeywell Honeywell Plaza Minneapolis MN 55408	Mod unspec	4
Med Spec (Add. unknown)	Mod MS-8	3
MSA 600 Penn Center Blvd Pittsburgh PA 15235	Mod 704 Mod A	6 17

	<u>MODEL</u>	<u>RESPONDENT NUMBER</u>
3. CARBON MONOXIDE (continued)		
Wilks Scientific Instruments The Foxboro Co. P.O. Box 435 Burlington MA 01803	Mod 101	14
4. HUMIDITY		
American Instrument Co. 8030 Georgia Ave Silver Springs MD 20910	Mod 15-3001	11
Draeger (Add. prev. given)	Test Tube Kit	22
E.G. & G. 151 Bear Hill Rd. Waltham MA 02154	Mod 911	3
Honeywell Honeywell Plaza Minneapolis MN 55408	Versa-trans Mod Y602P41-DD-74 111-75-V95 Mod unspec	4 18 9, 11
Hygrodynamics (Add. unknown)	Mod digital II	21
Kinergetics 6029T Reseda Blvd. Tarzana CA 91356	Mod CCU-02	15, 17
Panometrics 221 Crescent St. Waltham MA 02254	Mod 1000	11
5. HYDROCARBON		
Beckman (Add. prev. given)	Mod 108A	11
Texas Research, Inc. (Add. unknown)	Mod unspec	13
B. CARBON DIOXIDE SCRUBBERS*		
Duocom (Add. unknown)	Mod unspec	20

	<u>MODEL</u>	<u>RESPONDENT NUMBER</u>
B. CARBON DIOXIDE SCRUBBERS* (continued)		
Kinergetics (Add. prev. given)	Mod DH 11	5, 15, 16, 17
Linbergh-Hammar Asso. (Add. unknown)	Mod pura 787-M9	13, 17
Nova Scotia Research Foundation (Add. unknown)	Mod unspec	21
Worldwide Development (Add. unknown)	Mod unspec	3, 11
(*Units are equipped with Barolyme or Sodosorb canisters)		
C. AIR CONDITIONING		
Dunham Bush, Inc. 178 South St. West Hartford CT 06110	Chiller pkg	14, 22
Kinergetics (Add. prev. given)	Mod CCU-02	15, 17
Trane Co. 3600 Thomas Creek Rd. LaCrosse WI 54601	Mod S-1F5B38N	18
Worldwide Development (Add. unknown)	Mod unspec	3
Custom Designed		11
D. COMMUNICATION		
1. SPEAKERS		
Helle Engineering 7198 Convoy Ct. San Diego CA 92111	Mod unspec	20
Marvel Dive Communications (Add. unknown)	Mod unspec	3
Misco (Add. unknown)	Mod unspec	2

	<u>MODEL</u>	<u>RESPONDENT NUMBER</u>
1. SPEAKERS (continued)		
University Sound 1515 S. Manchester Ave. Anaheim CA 92803	Mod MIL-A Mod unspec	11 16, 18
Western Electric 222 Broadway New York NY 10038	Type L	17
2. MICROPHONES		
Sechrist Industries, Inc. 2820 Gretta Lane Anaheim CA 92806	Mod unspec	18
Shure Dynamic 222-T Hartrey Ave. Evanston IL 60204	Mod 562 Mod unspec	21 4, 16
Telex 9600 Aldrich Ave. Minneapolis MN 55420	Boom mounted on Headset	11
3. HEADSETS		
David-Clark Co, Inc. 370 Franklin St. Worcester MA 01604	Mod U3400	6
General Electric 316 E. Ninth St. Owensboro KY 42301	Mod unspec	3
Helle Engineering 7198 Convoy Ct. San Diego CA 92111	Mod unspec	20
Lafayette Radio 111 Jericho Turnpike Syosset NY 11791	Mod Numark	4
Telex (Add. prev. given)	Mod 2400 Mod HS-2,-3 Mod CS-61 Mod CS-75	17 17 13, 16, 21 11
Western Electric (Add. prev. given)	Mod unspec	18

<u>MODEL</u>	<u>RESPONDENT NUMBER</u>
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4. SOUNDPower PHONES

Stromburg-Carlson (Add. unknown)	Mod A281	13
	Mod 333	6
US Instrument Corp. Charlottesville VA 22902	Mod unspec	8
	Mod A257-2UL52	11

E. LIGHTING

External lighting systems used by	2, 3, 5, 6, 13, 15, 16, 17, 18, 19, 20, 21, 22	
Interior lights used by	4, 8, 9, 10, 11, 12, 15	
Fiberoptics J.M. Carty Associates, Inc. 117 Cornwall Ave. Tonawanda NY 14150	Mod unspec	3, 6, 16, 19, 21
General Electric 2432 Brockton San Antonio TX 78217	Mod unspec	4, 18

F. FIRE DETECTING AND EXTINGUISHING SYSTEMS

Pressurized water sprinklers (detection system not spec.)	3, 4, 6, 8, 11, 14, 15, 21, 22	
Hand-held water tanks/hose (detection method not spec.)	3, 4, 5, 8, 11, 14, 15, 21, 22	
Allen-Bradley Dept Tr 1201 S. Second St. Milwaukee WI 53204	Mod unspec	18
Duocom (Add. unknown)	Mod unspec	20
Edison Electronics Manchester Municipal Airport Manchester NH 03103	Mod 530	4

	<u>MODEL</u>	<u>RESPONDENT NUMBER</u>
F. FIRE DETECTING AND EXTINGUISHING SYSTEMS (continued)		
Fenwal 251 Main St. Ashland MA 01721	Mod unspec	19
Simplex 1137 N. MacArthur Springfield IL 62702	Mod unspec	16
Worthington Corp. 270 Sheffield St. Mountainside NJ 07092	Mod P28E284G	18
V. MEDICAL SUPPORT EQUIPMENT		
A. OXYGEN DELIVERY SYSTEMS		
1. MASKS		
Bennett Medical Equipment 12655 Beatrice St. P.O. Box 66934 Los Angeles CA 90066	Benefit	22
Foregger Co. 680 Old Willets Path Smithtown NY 11787	Anesthesia Mask	10
MSA 600 Penn Center Blvd. Pittsburg PA 15235	Mod unspec	13
Scott Aviation 2225 Erie St. Lancaster NY 14086	MBU5P Aviator Duo-Seal w/OB dump	11, 15, 16, 2, 4, 5, 6, 8, 17, 18, 19, 22
Vital Signs Inc. 1 Madison St East Rutherford NJ 07073	Scott Dual Seal Mod 9002	14 11
2. HOODS		
K.C.L. Corp P.O. Box 629 Shelbyville IN 46176		4, 5, 6, 8, 13, 15, 16, 17, 18, 22

2. HOODS (continued)

MODEL RESPONDENT NUMBER

Sierra Engineering Co.
123 East Montecita Ave
Sierra Madre CA 91024

Mod 22001 11

B. VENTILATORS

Bird Corp.
Palm Springs CA 92262

MK 7	8, 17
MK 8	11
MK 14	6, 13, 15, 16
Urgency bird	5
Mod unspec	9, 20

Cape Wayne
(Add. unknown)

Mod unspec 10

Emerson
22 Cottage Park Ave.
Cambridge MA 02140

Mod unspec 4

Flynn
Unit 5 Mississauga
Ontario Canada L5S 1C8

Mod unspec 19

Monaghan
(Add. unknown)

Mod 225 13, 22

Siemans-Elena
1765 Commerce Drive
Elk Grove Village IL 60007

Servo 18

C. ARTERIAL AND CENTRAL VENOUS PRESSURE MONITORS

Electronics for Medicine Inc.
1-T Campus Dr.
Pleasantville NY 10570

Mod M2103P 4

Hewlett Packard
175 Wyman St.
Waltham MA 02154

Mod 78342A 13, 17, 18

Mennen-Greatbatch
10440 Main St.
Clarence NY 14031

Mod 716-442-010 15

Statham
(Add. unknown)

Mod unspec 13

	<u>MODEL</u>	<u>RESPONDENT NUMBER</u>
C. ARTERIAL AND CENTRAL VENOUS PRESSURE MONITORS (continued)		
Tetronik Vitatek 5215 N.E. Elam Young Parkway Hillsboro OR 97123	Mod unspec	6
D. DOPPLER		
Imex, Inc. 6733 Sepulveda Blvd. Suite E Los Angeles CA 90045	Mod 09-00271	17
Meda-Sonics P.O. Box M Mountain View CA 94042	Versatone D-9	15
Parks Electronics Beaverton OR	Mod 811	13
Sodolec, D.U.G. (Add. unknown)	Mod unspec	3, 21
Ultrasonic 398 Reed Rd. Broomall PA 19008	Mod 811 Mod 812	4 18
E. BLOOD GAS MONITORS		
Corning Glass Works Corning NY 14830	Mod 165	11, 15
Instrumentation Labs, Inc. 113 Hartwell Ave. Lexington MA 02173	Mod 213/326	3
Nystrup (Add. unknown)	Mod unspec	10
Radiometer London Company 2750 Northseven Suite 305 Dallas TX 75229	Mod BMS 3MK2	13
Tetronik (Add. prev. given)	Mod unspec	6

	<u>MODEL</u>	<u>RESPONDENT NUMBER</u>
F. TISSUE OXYGEN		
Critikon P.O. Box 22800 Tampa FL 33622	Invivox (invasive)	15
Radiometer (Add. prev. given)	TCM 1 TCM 2 (transcutaneous)	15 15, 18
G. ELECTROCARDIOGRAPHS/DEFIBRILLATORS		
Cambridge Scientific Instruments P.O. Box 265 Cambridge MD 21613	Mod VS4B	11
Data Scope (Add. unknown)	Mod unspec	8
Electronics for Medicine, Inc. (Add. prev. given)	M1101c M12807	4 18
Electrodyne (defibrillator only) (Add. unknown)	DS95m	4
General Electric (Add. prev. given)	Mod 46-203462GIA Patient Monitor	15
Harco Corp. (defib only) 1057 Smith Rd. Medina OH 44256	Mod HAR 24	20
Hewlett Packard (Add. prev. given)	78342A Mod unspec Mod 1500	17, 18 8, 10, 13, 20 11
Marquette Electronics, Inc. P.O. Box 23181 8200 West Tower Ave. Milwaukee WI 53223	Mod 3100-E	3
Physio Control 11811 Willows Rd. Redmond WA 98052	Lifepack 4 Lifepack 5 Lifepack 6	5 19, 21 16
Tetronik (Add. prev. given)	Mod unspec	6, 22

	<u>MODEL</u>	<u>RESPONDENT NUMBER</u>
H. SUCTION APPARATUS		
Gemco (Add. unknown)	Mod 789	17
National Cylinder Gas (Add. unknown)	Mod 000302-63	18
N.C.G. (Add. unknown)	Mod Regu-gage	17
Ohio Medical Division of AIRCO, Inc. Madison WI 53701	Mod Ohio Intermittent Suction Unit	15, 16
Ohio Medical Products 3030 Aireo Drive Madison, WI 53707	Mod 321-7988-886	11
Puritan Bennett (Add. unknown)	Mod Venturi	4, 8
Vacudyne (Add. prev. given)	Mod unspec	14
Vaculette Aspirator (Add. unknown)	MAAS	3

VI. CHAMBER ODOR ABSORBENTS AND CLEANING COMPOUNDS

A. ODOR ABSORBENTS

Purifil	3, 11
Charcoal Bags	17

B. CLEANING COMPOUNDS

In a 9 August 1982 letter to the authors, Dr Jerry D. Stachiw, Chairman of the Committee on Viewports in Chambers for Human Occupancy, American Society of Mechanical Engineers, submitted a list of cleaning agents/disinfectants that are acceptable for use on acrylic plastic like Plexiglas. Because the list of cleaning agents is so massive, the authors had provided to Dr Stachiw samples of some of the more commonly used cleaning agents/disinfectants for testing.

1. The following cleaning agents/disinfectants did not initiate stress crazing or cracking on acrylic plastic and, therefore, can be used inside hyperbaric chambers with Plexiglas windows.

- a. Tergisyl (1:100 water solution)
- b. Lysol (1:100 water solution)
- c. Sani-Bactol (1:100 water solution)
- d. Amphyl (1:128 water solution)
- e. O-Syl (1:128 water solution)
- f. Sani Jet Spray (as received)
- g. Cidex (as received)

2. The following cleaning agents/disinfectants were found to initiate stress crazing and cracking in acrylic plastic and, for this reason, cannot be used inside hyperbaric chambers with Plexiglas windows.

- a. Ethyl alcohol (98% pure)
- b. Lysol Spray (alcohol solution)
- c. Amphyl Spray (alcohol solution)
- d. Viro-Tech Spray (alcohol solution)

- e. Staphene Spray (alcohol solution)
- f. Chlorothene Spray (alcohol solution)
- g. Windex (as received)
- h. Vesphine (alcohol base)
- i. Mask-Off (as received)
- j. Mikro-Quat FS (as received)

3. Dr Stachiw noted that, in general, water solutions of cleaning agents/disinfectants attack acrylic plastic less than alcohol solutions. For example, Lysol as an alcohol-based spray crazes acrylic, while Lysol 1:100 water solution does not. Similarly, alcohol-based sprays of Vesphine and Staphene craze acrylic, while Vesphine II (1:128 water solution) and Staphene (1:200 water solution) do not.

VII. CONCLUSIONS

Hyperbaric Medicine is a rapidly expanding treatment modality. Thus, it is becoming increasingly important to make available a list of medical and chamber support equipment that can be used in the high-pressure environment. As indicated in this document, a wide variety of medical and chamber support equipment is currently being used in hyperbaric facilities. Information on the items listed herein was provided by the various respondents. It is, therefore, presumed, but not verified, by the authors that the items function as advertised in the hyperbaric facility. Certain equipment listed may not be used inside the chamber, that is, physically placed in the pressure environment. For example, many of the carbon dioxide, carbon monoxide, and oxygen analyzers would be positioned outside the chamber with sampling of the gas exhausted from the chamber and reduced to atmospheric pressure. There may also be equal or better items in each category that are not known to the authors. The inclusion of any item on this list does not constitute an endorsement by the authors or the United States Air Force.